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ARTILLERY.—*The problem of anti-aircraft firing.*[1]

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At the beginning of the war it was almost impossible to foresee what would be the development of aviation in the army and what developments in anti-aircraft artillery would of necessity follow. The object of artillery against aircraft is above everything else to prevent the enemy machines from fulfilling their mission of observation. Although there are those who seem to think that the present and future rôle of aviation consists mainly in dropping bombs, it must be said that this is a decided error. The principal rôle of aviation is not in the dropping of bombs but in observation.

The flying machine should be considered not so much one of the arms of the artillery as one of its eyes—and that eye the better one.

In fighting the enemy aircraft our guns fight the artillery of the enemy in its most vital part. The artilleryman who fires, or orders firing, against aircraft should never forget the importance of his rôle, which is to render the artillery of the enemy practically useless by blinding it.

At the outbreak of the war there were only a few types of anti-aircraft guns in our army, and as far as we know there was no special anti-aircraft gun in the German army. On both

[1] A lecture given before the Washington Academy of Sciences on April 18, 1918.

sides, the aircraft war was considered as a supplementary duty for the field matériel and this duty had to be fulfilled by whatever means could be improvised (burying the trail of the gun, etc.).

In proportion as the war developed, the invention and extension of a special anti-aircraft matériel have taken on greater and greater importance in the armies of the Allies as well as in the German army, and this in proportion to the importance taken by the means employed for aerial observation.

The object of this lecture is not to study the improvements made in anti-aircraft matériel but to follow in its different stages and up to the point where it is, today, the study of the general problems which anti-aircraft war has presented to the minds of artillerymen.

I

As long as the objectives of artillery were terrestrial targets the interest in the study of the trajectory seemed to be limited:

(*a*) To the initial part of the ascending branch (angle of elevation, angle of jump, angle of projection or departure, clearing angle, etc., etc.). The study of the initial part of the ascending branch was entirely oriented in the double problem of defilade and range.

(*b*) To the terminal part of the descending branch (angle of fall, angle of impact, angle of protection, angle of ricochet; the apparent elevation of the burst, etc.). The study of the terminal part of the descending branch was entirely oriented in the problem of the vulnerability of the target according to its nature or its location.

When it was a question of firing at aerial targets the tendency at first was, and this is easily comprehensible, to argue in regard to these targets as if they were merely terrestrial targets raised to a very high angle of sight. One of the first results of this theory was to erroneously apply to these targets: first, the idea of a normal height of burst (hauteur type) above the target that would give the maximum effect; second, the hypothesis of the rigidity of the trajectory.

In the same manner there was at first transferred to the sphere of firing against aerial targets the general principles of ranging (jump, bracket, etc.), which were in use in firing against terrestrial targets.

Finally, when it was a question not of firing at balloons, but at flying machines, not of firing at fixed objects but at objects in motion, it was first thought that the methods of firing should be similar to those employed against marching troops, against a train, etc.

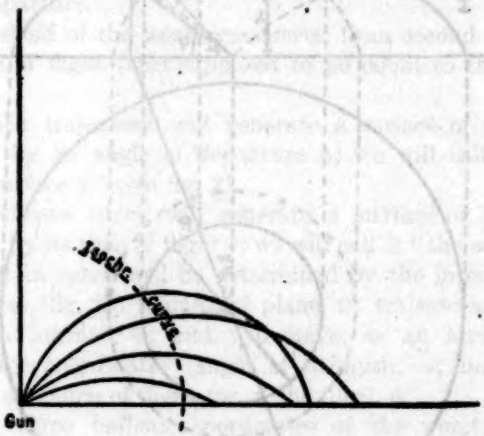


Fig. 1.

From this came the method of ranging called "de la tenaille" and others of the same kind. From this came, too, the considerable efforts made to employ the range finder and to make use of the data obtained through this instrument (that is to say, the actual distance of the target) in order to determine the fuse setting.

Gradually, experience having demonstrated that this very simple method of transposing into the ballistic problems of space solutions which were only appropriate to the ballistic problems of terrain, only led to decided errors and to notorious inefficiency, the following general ideas were reached:

II

(*a*) A point in space taken as a target for a given gun is defined by:

(1) The azimuth in which it is located.

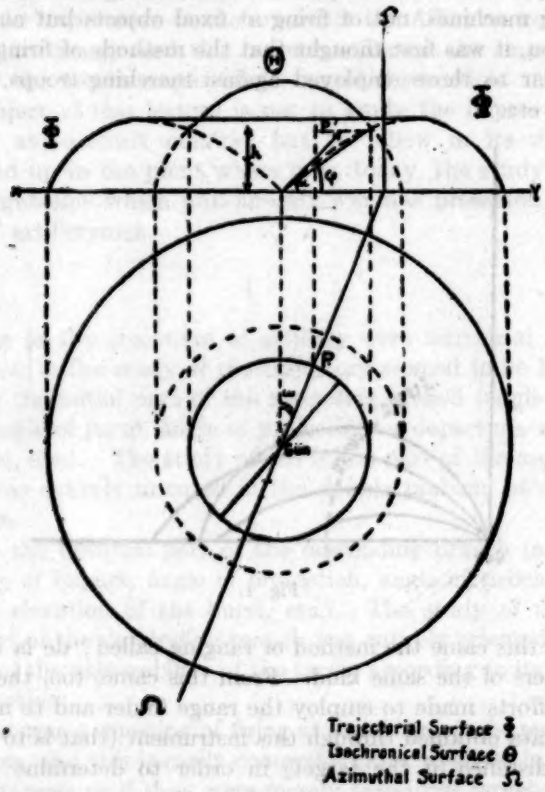


Fig. 2.

(2) The trajectory on which it is located in this azimuth, this trajectory being itself defined for the given gun by the angle of departure.

(3) The setting of the fuse which on the said trajectory will determine the burst at the said point.

If we draw on a vertical plane (fig. 1) the locus of all points of burst obtained on the various trajectories by a given fuse setting, we shall then have a curve. This curve will be the locus of the points which the projectile reaches within a given time (time of fuse) if the fuse is a clock-fuse. For that reason it would be proper to call the curve an isochrone curve.

Now let us turn around through all the azimuths a vertical plane on which has been drawn the diagram showing:

(1) The sheaf of the trajectories from degree to degree of angle of departure.

(2) The sheaf of the isochrone curves from second to second of the time of flight (this supposed to be equal to the time of fuse).

Thus, each trajectory will generate a surface of revolution determined by its angle of departure ϕ; we will call this surface "the surface Φ" (see fig. 2).

Each isochrone curve will generate a surface of revolution determined by its time of flight θ; we will call it "the surface Θ."

Any point in space will be determined by the intersection of three surfaces (fig. 2): azimuthal plane, Ω; trajectorial surface, Φ, isochronic surface, Θ; and will have, as an aerial target, three ballistic coördinates: angle of azimuth, ω; angle of departure, ϕ; and time of flight (or of the fuse), θ.

Of these three ballistic coordinates of the point, the azimuth only is at the same time a geometric coordinate.

As the geometric coordinates are the only ones that can be obtained by direct measurement, in particular by sighting, the ballistic coordinates ϕ and θ have to be obtained indirectly, by the following means, for instance:

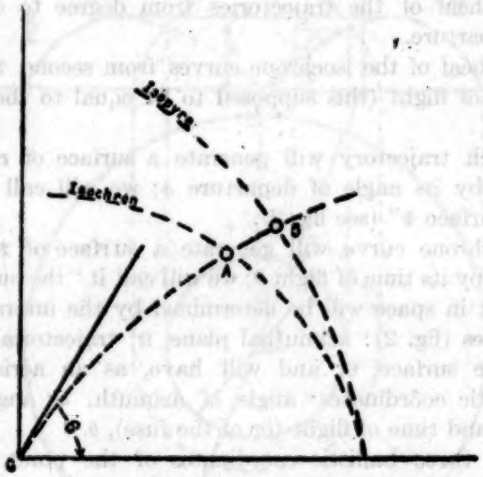
The target will be located in the azimuthal diagram by the measurements of its altitude and of its angle of sight (apparent elevation α) and, once it is thus located in the plane of the diagram, a simple reading will tell on which trajectory and on which isochrone it is.

III

In the preceding paragraphs we have taken for granted that the time at the end of which the shell burst is equal, whatever

may be its trajectory, to the time marked on the time-scale of the fuse.

But this is true only for clock-fuse. For the ordinary fuse the time of bursting is determined by the duration of combustion of a certain length of a communicating tube; this tube carries from length to length a time-scale which indicates the time which this combustion will take in the atmosphere near the earth.



A Burst with clock-fuze at time θ
B " " ordinary fuze set θ

Fig. 3.

For example, a fuse set at ten seconds burns for ten seconds before bursting, if the region in which the combustion takes place is normal. Transport the fuse to another place in which for example, the air is more rare, that is to say, less dense, and instead of lasting ten seconds, the combustion will last eleven or twelve.

It follows from this, that the locus of the points of burst for a given fuse setting is not the isochrone curve corresponding to an equal time of flight. In the high regions of atmosphere the

combustion of the fuse is delayed by the dilution of the air, and the burst occurs not on the isochrone curve but further along, on another curve which deviates from the former in proportion to the time during which the projectile, before bursting, has been subjected to a lower barometric pressure. This other curve, depending upon a geometric length of combustible tube and not upon a chronometric length of flight, is sometimes called the "*isopyre curve*" (fig. 3).

Since the beginning of the war the empirical outlining of the isopyrical curves and of the trajectories for high altitudes has been the object of very careful work in which thousands and thousands of projectiles have been used. A standard diagram has been established (Puteau-Arnouville, 1915–16), which, used either in its original form or more or less ingeniously transformed, constitutes the essential instrument of all the methods of firing against aerial targets.

IV

Anti-aircraft firing does not consist merely in firing at an aerial target, but in firing at an aerial target *in motion*. Moreover, this target moves with a speed which cannot be regarded as negligible with reference to the speed of the projectile designed to strike it.

With an average wind, an "observation machine" attains a speed of 35 meters (38.15 yards) per second. At ordinary firing ranges the time of flight of the projectile amounts to twenty seconds. It follows that, under normal conditions, the distance covered by the target, between the moment at which the projectile designed to strike it is fired and the moment at which it bursts is about 700 meters.

What will be its course? How can the gunner locate in advance the position in space where the target and the projectile will meet after both have followed their respective trajections for the same length of time? This is the problem sometimes called, especially by the British, the problem of *prediction*.

The target being an animated one and having, as one might say, its own will-power, it is *a priori* obvious that no absolute and definite solution can be applied to the problem. During

twenty seconds a flying machine has time to change its course in various sudden and unexpected ways, both as to altitude and as to direction. The problem has nevertheless a probable solution and this solution belongs to the domain of mathematical *extrapolation* based on the laws of continuity, to wit:

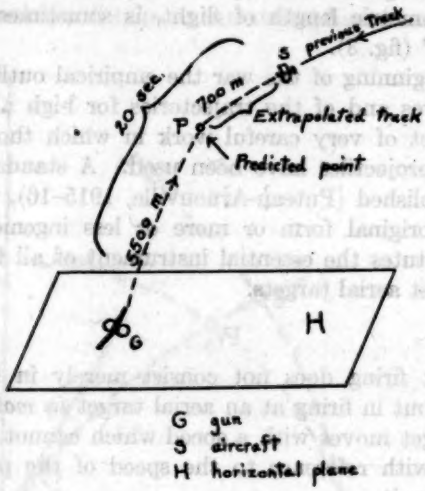


Fig. 4.

A moving body that has covered, with uniform speed, a curve *ab* in space during the time t should, at the end of a total time $t + dt$, reach a point c, such that $\frac{bc}{ab} = \frac{dt}{t}$. This is nothing else but the equation of uniformity of speed.

If the curve in space *ab* is given in terms of the parameter t by the equations:

$$x = f_1(t)$$
$$y = f_2(t)$$
$$z = f_3(t)$$

the coördinates of the extrapolated point c will be given by the same equations by replacing t by $t + dt$.

If the curve ab, in the vicinity of b, has no pronounced curvature, the point c can be considered as located on the tangent to that curve drawn from point b in the direction of movement.

The problem of extrapolation with respect to the flying machine (fig. 4) is, with one dimension added, a problem quite similar to the ones commonly dealt with in firing at moving targets at sea, and worked out by the coast artillery by means of the *plotting board:*

The positions s_1, s_2, s_3 of a ship are, by triangulation, registered on the plotting board at the times t_1 t_2, t_3. The point s_4 at which it is necessary to aim in order to reach the ship at the time t_4 is given by a graphical extrapolation of the plotted track s_1, s_2, s_3.

The solutions which have been given to the same problem in space with respect to anti-aircraft firing are of two general kinds:

(1) Solution by measurements of the angular velocity of the target.

(2) Solution by measurement of its linear velocity.

(1). The angular velocity of a flying machine with reference to the eye of the observer (or with reference to the position of the gun if observation is supposed to be made from this position) may be considered as being the resultant of two angular velocities, measured, one in the plane of deflection, the other in the plane of sight. The instruments which have been invented in order to deal with solution (1) have been mostly based on this resolution of speed.

At this point it is important to note that the angular velocity of a flying machine moving with a uniform linear velocity changes value every minute, except in very exceptional and very improbable cases; for example, the case of a flying machine which might happen to be revolving around a vertical passing through the eye of the observer. Consequently, the measurement of angular velocity taken at a given time can be considered as available only during a very short while.

Supposing even that the angular velocity measured at the very moment of the shot could be applied to extrapolate for the point which the projectile ought to reach, and this is question-

able owing to the relatively long duration of the flight, any measurement taken at a moment somewhat prior to the firing of the shot is evidently out of date and has no value whatever regarding the extrapolation desired.

This is the reason why, after the trials made with instruments capable of giving from time to time discontinuous measurements of angular velocities, it has been felt necessary to substitute for them instruments for continuous measurements, such as the galvanometric cinemometer.

This instrument is based on the following principle: A steel armature which turns inside of a solenoid develops a current of induction, the intensity of which is a measure of the velocity of rotation. If the steel armature is secured on the axis of a sighting-telescope pointed at the flying machine, a galvanometer duly graduated will enable one to read constantly the angular velocity of the flying machine.

(2) The solutions of the second kind are based on the measurement of the linear velocity. A very great majority of these solutions have assumed as an hypothesis that the measurement of the horizontal linear velocity gave sufficient data for firing; that is to say, that it could generally be considered that the altitude of a flying machine did not alter much during the time of the flight of the projectile. It goes without saying that these solutions also assume as an hypothesis that the speed of the flying machine in regard to the problem of firing can be considered as uniform. This admitted, a measurement of linear velocity, taken at any moment, remains available.

All the instruments based on the solutions of the second kind have been based on the same principle as that of the *plotting-board*. Some of these have endeavored to draw automatically by simple sighting a continuous track of the course of the flying machine. It seems that it is in line with this idea that the most handy and useful, if not the most complete, instruments will be found.

V

To sum up, the problem of anti-aircraft firing, after many experiments, is at present, if not solved, at least plainly laid out in the following way:

To be preliminarily measured: (1) altitude of the flying machine; (2) its orientation and its velocity (angular or linear); (3) extrapolation or prediction of the point to be aimed at; (4) wherefrom the knowledge of the azimuth of the said point; (5) wherefrom, too, in the azimuth the reading on a diagram of the ballistic coordinates of the said point (trajectory and isopyre) as functions of its geometric coordinates (angle of sight and altitude).

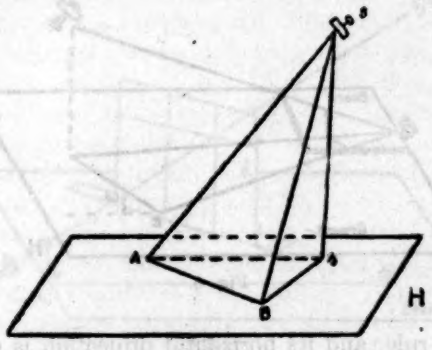


Fig. 5.

Finally, a word in regard to the methods of measuring:

(1). The altitude (h) is measured by triangulation from a large observation base.

The flying machine is the summit of a pyramid occupying the space $S.\ s.\ A.\ B.$ placed on the horizontal plant H (fig. 5). $A.\ B.$ is the line of measurement called the horizontal base, at the two extremities of which are two posts of observation, the distance between them being known. s is the horizontal projection of the flying machine.

Any triangulation made in order to solve the pyramid will give the knowledge of the altitude h.

Among these methods the one to be pointed out in particular is the direct method which consists in the following:

The observer B announces simply by telephonic signal the successive passages of the flying machine in the azimuths 1, 2. 3—determined in advance, for example every ten degrees, starting from the true south.

The observer A moves on a plotting-board a vertical rule along the azimuth for which the first signal is expected and this in such a way as to sight the flying machine on the edge of this rule.

At the moment of the telephonic signal the altitude h of the machine is given by simply reading the height at which it ap-

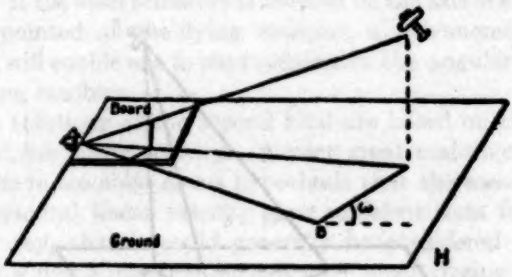


Fig. 6.

pears on the rule; and its horizontal projection is given by the position of the lower end of the rule (fig. 6). The board is supposed to be duly oriented and scaled; the rule to be accordingly scaled.

Remarks. (*a*) This direct method permits the continuous tracing of the flight of the machine, once its altitude is known. If, in fact, after the signal, the observer A keeps on moving his vertical rule no longer along the azimuth but in such a way that the flying machine is maintained sighted at the same altitude h on the edge of the rule, the lower end of the rule will automatically trace on the board the projection of the flight of the machine (taking for granted, of course, that the machine does not change its altitude).

(*b*) This same method permits one to control or rectify periodically the measurement of the altitude. Thus, suppose the observer *A* operating as has just been said; the signal of observer *B* announcing the passage of the machine in the next azimuth will be heard: either at the same time as the lower end of the rule crosses the said azimuth drawn on the plotting-board, in which case the altitude has not changed; or before the reaching by the lower end of the rule of the azimuth, in which case the machine has gone higher; or after the passage of the lower end of the rule on the azimuth, in which case the machine has come down.

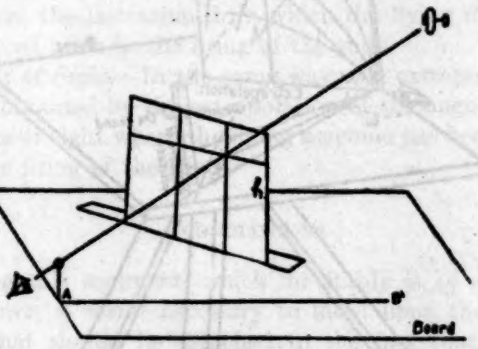


Fig. 7.

In the last two cases the observer *A*, as soon as he hears the signal, will recall or send back his rule along the sighting plane so as to replace it on the azimuth announced; from this will result the rectification of the reading of the altitude and also the rectification of the horizontal projection of the flying machine.

(2) The linear velocity may be measured in the following way (fig. 7):

A given length of a horizontal wire, for instance, 1 cm. representing 100 meters and thus corresponding to a scale of 1/10,000, is stretched across a vertical aperture at such a height above the plane of the board as to represent the altitude of the flying machine (for example, 20 cm. representing 2 kilometers).

The observer A, after having trained the aperture in such a way that the machine aimed at appears as if following the wire, registers the time taken by the machine to cross the aperture from one side to another.

This time gives the measure of the horizontal linear velocity and the bearing of the plane of the aperture indicates the actual direction of the flying machine.

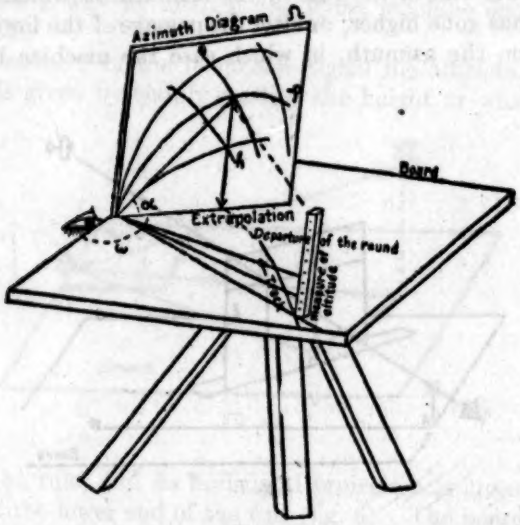


Fig. 8.

(3) The extrapolation or prediction results from the knowledge both of this actual direction and of the linear velocity.

As has already been said, this extrapolation gives the azimuth of the point to be aimed at; and, in this azimuth, the angle of sight (fig. 8).

The altitude of the point to be aimed at in the extrapolated azimuth is supposed to be equal to the last altitude that has been measured. The angle of sight results from the knowledge of the altitude and of the abscissa; the latter is given by the intersection of the azimuth with the extrapolated horizontal direction.

(4) The ballistic coordinates (angle of departure, fuse-setting) are read on the diagram of the trajectorial and isopyrical curves; a diagram on which the point to be aimed at has just been fixed by the knowledge of its angle of sight and of its altitude (or merely of its abscissa and ordinate).

(5). If one proceeds by measurement of angular velocities instead of by measurements of linear velocities the instruments used are the continuous electric cinemometers already mentioned above, and then the extrapolation is determined as follows:

(*a*) *Azimuth.*—The extrapolated azimuth is obtained by the extrapolation of the horizontal angular velocity and this in starting from the last azimuth in which the flying machine has been observed prior to the firing of the shot.

(*b*) *Angle of Sight.*—In the same way, the extrapolated angle of sight is obtained by the extrapolation of the angular velocity in the plane of sight where the flying machine has been observed prior to the firing of the shot.

CONCLUSIONS

In ending this comment, which inevitably is of a very general character, it seems necessary to insist upon the great importance that should be attached to the fact that, as far as possible, the nature of the firing conditions should be such as not to disturb the continuity of the flight of the flying machine between the moment at which the measurements that determine the firing data have been taken and the moment at which the shot reaches its destination.

As has been said, a flying machine may cover about 700 meters during the flight of the projectile. During this period the race is most unequal.

On one hand, the projectile, just carrying away the measurements and the intentions of the battery commander, is merely an inert instrument of a previous will. It clings helplessly to its trajectory and will inevitably burst once the combustion of its fuse has come to an end. On the other hand, the aerial ship has maintained the full power of her free will, her trajectory is

not compulsory and may be altered in accordance with her own desires.

Therefore, if she becomes conscious that a projectile intended for her is on the way, she is in a position to baffle all the calculations of which this projectile is the unconscious carrier.

What, then, is any observation worth, even though it be minutely exact, that the gunner can figure out in regard to the deviations between his points of burst and the objective? To what extent do these deviations indicate an error of firing which is subject to rectification? To what extent are they the effect of a modification in the continuity of the flight of the objective, voluntarily brought about by the pilot during the course of the projectile?

The first burst that will take place and which the pilot will see will give him the alarm and from this moment on, what craftiness, what feat of strength in case of need, will he not make use of in order to avoid falling into the net of subsequent trajectories?

Are not these points of interrogation sufficient to make it clearly understood that the systems of anti-aircraft firing based solely on ranging must be condemned as being ineffective and excessively expensive?

Are they not sufficient to show that so long as there shall not have been found a gun of a fantastic muzzle velocity, capable of pouring into space projectiles of a speed infinitely superior to that of the flying machine, the gunner must concentrate all his attention and all his ingenuity in operating sudden and dense barrages on points of extrapolation silently determined by measurements as accurate as possible?

CRYSTALLOGRAPHY.—*The assignment of crystals to symmetry classes.* EDGAR T. WHERRY, Bureau of Chemistry.

The thirty-two classes of crystals are founded on so firm a basis that it has become customary to regard the assignment of a crystallized substance to one or the other of them as one of the fundamental aims of crystallography. Evidence has been accumulating for some time, however, that certain substances are in a sense intermediate between classes, possessing simultaneously

TABLE 1

EVIDENCE FOR ASSIGNMENT TO CRYSTAL CLASSES

SUBSTANCE	COMPOSITION	ASSIGNMENT BASED ON					
		Habit	Etch-figures	Electric polarity	Optical rotatory power	Automatic structure	
						Space-lattice	Structure-unit
Cubic system							
Diamond	C	Holohedral or tetrahedral	Tetrahedral	Holohedral		Holohedral	Tetrahedral
Sylvite	KCl	Holohedral	Gyrohedral		Holohedral	Holohedral	Gyrohedral
Cuprite	Cu_2O	Holohedral or gyrohedral	Holohedral		Holohedral	Holohedral	Gyrohedral
Pyrite	FeS_2	Pyritohedral or Tetartohedral	Pyritohedral	Tetartohedral	Indeterminate	Pyritohedral	Tetartohedral
Barium nitrate	$Ba(NO_3)_2$	Tetartohedral	Tetartohedral	Pyritohedral	Pyritohedral	Pyritohedral	Tetartohedral
Tetragonal system							
Rutile	TiO_2	Holohedral or trapezohedral	Holohedral	Holohedral	Holohedral	Holohedral	Trapezohedral
Rhombic system							
Sulfur	S	Holohedral or bisphenoidal	Holohedral	Holohedral	Holohedral	Holohedral	Hemihedral
Manganite	MnO(OH)	Holohedral or bisphenoidal	Holohedral	Holohedral	Holohedral	Holohedral	Hemihedral

some of the attributes of two of them. In table 1 the data in several instances of this relation are presented, the hemihedrism being in every case weak, according to the classification of Professor Goldschmidt.[1]

Diamond, in the majority of text books of mineralogy, is classed as tetrahedral, and Fersmann and Goldschmidt[2] concluded from a review of extensive data that it actually possesses weak hemihedrism of this type. Attempts to develop piezo- and pyroelectricity have, however, been unsuccessful,[3] which points to holohedrism. In the presence of such conflicting evidence, the assignment of a substance to one class or another has in the past been a matter of opinion on the part of the individual scientist, depending on the relative weights assigned to different features.

When the study of crystal structure by X-rays became, especially through the brilliant work of the Braggs,[4] capable of demonstrating the exact positions of the atoms in crystal space-lattices, there seemed reason to hope that it would be possible to decide such questions, and classify each substance accurately, definitely, and finally. But when the structure of diamond was worked out, it proved, as a whole, to be holohedral, while the structure-units (unit cells of the space-lattice), are tetrahedral in symmetry, leaving the decision as to which class it shall be assigned still in doubt.

If it be admitted that a substance can belong to two classes at the same time, this difficulty vanishes. There being then no longer need for any evaluation of the relative importance of different features in determining the classification of the crystal, the significance of all the physical properties may be considered on an equal footing. Habit, in so far as it represents a condition of equilibrium, should be connected with the structure as a whole; in diamond it should be holohedral, which is actually observed to be the case in the majority of crystals of this sub-

[1] GOLDSCHMIDT and NICOL. Neues Jahrb. Min. Geol. 1904[1]: 109; NIES and GOLDSCHMIDT. Op. cit. 1908[2]: 99.

[2] Der Diament, 1911.

[3] VAN DER VEEN. Zeitschr. Kryst. Min. 51: 545. 1909.

[4] X-rays and Crystal Structure, 1915.

stance. When, on the other hand, external conditions prevent equilibrium from being attained, the symmetry of the structure-unit may conceivably find expression in the development of the faces, and, as a matter of fact, a tetrahedral or hextetrahedral habit is too frequently exhibited by diamond to be considered an accident.[5] Etch-figures bring out partial symmetries when they are produced under conditions where attainment of equilibrium is delayed, and in diamond they are actually hemihedral at first, and become holohedral in the later stages of development. The electric polarity, however, should be determined by the structure as a whole, which holds in this case. Rotation of the plane of polarized light, as it could not occur in a tetrahedral substance in any case, has no bearing on the matter. The features of diamond thus agree with its assignment to two different classes at the same time, and its crystallization may be stated in the following manner:

System, cubic; structure, holohedral; structure-unit, tetrahedral.

In sylvite the habit and the absence of optical rotatory power correspond to a holohedral structure, which is found to be present by the X-ray examination. In this case electric polarity could not occur, as no polar axes are present under any interpretation. But on the basis of the gyrohedral symmetry shown by the etch-figures this substance is commonly assigned to that class. As pointed out by the Braggs a very slight distortion, which might have sufficient influence on the growth of the crystal or development of etch-figures to give rise to the gyrohedral symmetry observed, would not affect the X-ray spectra to a recognizable extent; the structure as a whole might then be essentially holohedral, while the structure-units are not. Such a relation was in fact predicted by Barlow and Pope[6] some years before the development of the X-ray methods. They pointed out that if, in a close-packed cubic assemblage of atoms, alternate ones are of slightly different sizes, gyrohedral symmetry would neces-

[5] This word is not to be taken too literally; it is merely a convenient descriptive term for phenomena, the causes of which do not at a given time appear worthy of extended investigation.

[6] Trans. Chem. Soc. 91: 1179–1187. 1907.

sarily result. As all available data indicate that the atomic volume of potassium is decidedly greater than that of chlorine, this symmetry would be expected with potassium chloride. It may be pointed out here that in the case of sodium chloride the atomic volumes of the two elements are essentially identical, and no gyrohedrism should be exhibited; and as a matter of fact, the etch-figures on this substance, as well as all of its other properties, are completely holohedral. On the other hand, in practically all the other alkali halides, including those of ammonium, a difference of volume must be present, and gyrohedral symmetry is to be expected; and this has been thoroughly confirmed by etching experiments. The crystallization of these halides may therefore be described as:

System, cubic; structure, holohedral; structure-units, gyrohedral.

The relation in the case of cuprite corresponds to that of the halides, except that here for some obscure reason the gyrohedrism is shown by forms occasionally found upon the natural crystals rather than by the etch-figures. The explanation of the symmetry is no doubt the same as with the halides, copper having a less volume than oxygen. The crystallization of this substance may accordingly be described as:

System, cubic; structure, holohedral; structure-unit, gyrohedral.

The pyrite group is a particularly good illustration of the relation here under consideration. Many crystallographers have considered all the members of this group to be tetartohedral, because of occasional tetrahedral development of forms capable of showing it, accompanied by typical dyakis-dodecahedral or "pyritohedral" symmetry of other forms. The thermo-electric behavior is also regarded as tetartohedral in character. The etch-figures appear, however, not to depart from simple pyritohedral relations; and no information can be obtained from optical properties, as no method of measuring optical rotatory power on opaque, metallic, minerals has as yet been developed. The X-ray studies made by the Braggs of three members of this group, pyrite (FeS_2), hauerite (MnS_2), and cobaltite (CoSAs), show the

space-lattices and crystal molecules (in so far as the structure of the latter affects X-rays) of the first two to have pyritohedral symmetry, while the last is tetartohedral. It is to be inferred that all members of the group in which the two negative atoms are alike would show the first type of symmetry, those in which these atoms are unlike the second. The fact that many specimens of pyrite actually show some tetartohedral features indicates that the two sulfur atoms in these instances at least must be unlike, not sufficiently to affect the X-ray spectra, yet distinctly enough to influence the habit and electrical properties. This could occur if one of the sulfur atoms were tetravalent, the other divalent, the structural formula of the compound (whenever such a formula could apply) being Fe = S = S. On the other hand the tetartohedral properties may be limited to pyrites in which enough of the sulfur atoms, scattered through the mass, are replaced by arsenic or some other element to give the structure the symmetry characteristic of the CoSAs class of compounds. Further work will be necessary to decide between these two possibilities, but it is evident that the crystallization of at least some specimens of pyrite may be described as:

System, cubic; structure, pyritohedral; structure-unit, tetartohedral.

Barium nitrate and the isomorphous strontium and lead salts have been studied by X-rays by Nishikawa and Hudinuki,[7] and their space-lattices found to possess pyritohedral symmetry. The habit and etch-figures are often tetartohedral, however, although neither electric polarity nor optical rotatory power have been observed in the crystals. The structure-units may therefore possess the diminished symmetry, while the structure as a whole is pyritohedral:

System, cubic; structure, pyritohedral; structure-unit, tetartohedral.

The crystal habit of rutile is usually holohedral, but hemihedrism of an apparent trapezohedral type occasionally appears.[8] The two series of observations which have been made

[7] Proc. Tokyo Math. Phys. Soc. II, 9: 197. 1917.

[8] SCHRAUF, Zeitschr. Kryst. Min. 9: 433. 1884.

on this substance with X-rays have yielded contradictory results; Vegard[9] interpreted his data as indicating a sphenoidal arrangement of the oxygen atoms, while Williams[10] worked out a trapezohedral configuration of the structure-unit, the structure as a whole being holohedral. The second view seems on the whole the most reasonable, so the crystallization of rutile, as well as of cassiterite and zircon, which belong to the same group, should probably be stated as:

System, tetragonal; structure, holohedral; structure-unit, trapezohedral.

The structure of sulfur has not been fully worked out by X-rays, as it shows a peculiar abnormality in the spacing of the planes in the direction of the vertical crystal axis. No assignment of the structure-unit to a special symmetry class is possible, but it may be pointed out that the habit of the crystals of this substance is sometimes decidedly bisphenoidal, whereas the remaining properties are holohedral, which indicates a relation similar to that shown by the other substances here considered.

Manganite has not been studied by X-rays at all, and it possesses metallic properties to such an extent that neither electric polarity nor optical rotatory power can be observed. But a bisphenoidal distribution of faces has been observed on crystals of it from many localities, and crystals altered to pyrolusite from Virginia recently studied by the writer[11] show in addition hemimorphism along the right-left crystal axis *b*. The hemimorphism in this case appears to be merely a result of difference in rate of growth, since the forms observed at both ends have essentially the same symbols, and moreover, etching figures on this mineral exhibit holohedral symmetry. It may therefore be suggested that in manganite the structure-unit possess some hemihedral feature not present in the structure as a whole, and this finds expression in the peculiarities observed in the distribution of faces.

The evidence collected in this paper appears to justify the conclusion that both the symmetry of the space-lattice as a

[9] Phil. Mag. VI, **32**: 90. 1916.

[10] Proc. Royal Soc. A. **93**: 418. 1917.

[11] To be described shortly in collaboration with Prof. THOMAS L. WATSON.

whole and that of the crystal-molecules or unit cells of the lattice may find expression in significant physical features, and therefore that both should be taken into account in the assignment of crystals to symmetry classes, even though it may at times be necessary to state two different classes for the same crystal.

BOTANY.—*A sketch of botanical activity in the District of Columbia and vicinity.*—I. P. L. RICKER, Bureau of Plant Industry.

It would perhaps be difficult if not impossible to say who started the first botanical work in the present District of Columbia which, as nearly virgin wilderness, much of it swamp land, was ceded to the United States Government by the State of Maryland in 1788. It would be much more difficult if we included the part in Virginia ceded to the United States in 1789 and the area in Maryland surrounding the District. The fact that Georgetown was settled late in the 17th century, although not formally laid out until 1751, and Alexandria at least as early as 1749, opens up a wide possibility.

Rev. John Banister was probably the first to do much active botanizing in Virginia, where he died about 1692. Ray (see bibliography) makes no definite reference to his collecting near the Potomac, although it is quite probable that he did some collecting within the range of this flora.

John Clayton came to Virginia in 1705. The list of his plants published by Gronovius in 1743 shows that he collected Betula nigra "a cataractis fluminis Potamoc," which might indicate any one of several points from Little Falls to Great Falls.

George Washington began making improvements at Mount Vernon soon after it came into his possession about 1759. It is possible that a careful examination of his voluminous correspondence and diaries at the Library of Congress, which time does not permit at present, might give more definite ideas as to his plantings, many of which were doubtless introduced from Europe. He did however plan for a Botanical Garden in the District. André Michaux, the French botanist, visited Washington at Mount Vernon, June 19, 1786, on his way to New

York where he had planned to start a Botanical Garden.[2] There seems to be no evidence of his collecting specimens in the Potomac region at this time except that as he was on a mission from the King of France to collect seed for the Royal Botanical Garden at Paris it is not at all improbable that some specimens were collected here.

It seems likely that the first local American who had any accurate knowledge of the native plants and their names was Thomas Jefferson, and this knowledge is abundantly proven in his correspondence. He entered Washington's cabinet as Secretary of State in 1789, and although the seat of government was not moved from Philadelphia to the District of Columbia until June, 1800, he was doubtless here frequently on his way to Monticello. That his official duties here were no bar to his collecting plants is well shown by the request of one William Hamilton in 1808 for seed of one of the hollies. After three failures by local amateurs to secure the right seed, Jefferson was forced to do the collecting himself and obtained it at the first attempt.

In view of his well-known interest in plants, Jefferson, on the removal of the government to Washington, was immediately besieged by offers from gardeners[3] to establish a botanical garden in the District. At the time he did not consider it the function of the government to do so. The plan was also opposed in Congress, where the idea of a botanical garden seemed to be an institution to furnish the District with cheap vegetables and flowers.

While none of the early nurserymen of the District gave any attention to the scientific aspect of their subject or of botany, yet, considering them botanists in a broad sense, they have contributed much to the practical side of the science. Thomas Main, a Scotch gardener, who settled at Georgetown about 1804, was probably the first nurseryman of the District. His attention was given almost entirely to raising grapes for wine.

[1] Washington correspondence, Michaux to Washington, June 20, 1796, and Washington's diary of June 19, 1796.

[2] This garden was eventually established at Charleston, S. C., by the son, François André Michaux, who came there in 1805.

[3] Jefferson correspondence.

Constantine Samuel Rafinesque-Schmaltz[4] prepared the first list of District plants in 1804, the forthcoming publication of which was announced by him in 1805, but for some unknown reason it never appeared.

The first actually published list of District wild plants was given by David B. Warden[5] in 1816. While there are numerous notes on introduced cultivated plants in this work by Warden the nine pages of local wild plant names relating to 130 species were furnished by José Francisco Correa da Serra[6] Portuguese minister to Washington, but who resided most of the time at Philadelphia and succeeded Benjamin S. Barton as lecturer on botany at the University of Pennsylvania.

In 1817 a sufficient number of residents of the District being interested in botany, a public notice of the intention of forming a Botanical Society was given, and on March 13, 1817, a meeting was held for this purpose at Davis's Tavern. Dr. John A. Brereton, an assistant surgeon in the U. S. Army, was called to the chair and John Underwood appointed Secretary. A committee of three, consisting of Rev. Dr. James Laurie, George Watterson, and Dr. Alexander McWilliams, was appointed to draw up a constitution for the Society, which was called the Botanical Society of Washington.[7] The Society held meetings

[4] FITZPATRICK, T. J. F. Rafinesque, a sketch of his life and bibliography. Des Moines, Iowa, 1911.

[5] WARDEN, DAVID BAILLIE. A chorographical and statistical description of the District of Columbia. Paris, 1816. Dedicated to his friend Mrs. Custis. He had served as a U. S. consul in France.

[6] José Francisco Correa de Serra, born at Serpa, Portugal, in 1750, assisted in founding the Portugese Academy of Sciences and was made perpetual secretary. He left Portugal for France in 1786 on account of political troubles and went to England in 1797 where he became secretary of the Portugese embassy. He came to New York in 1813 and received his appointment to Washington in 1816. He was called home in 1820 and elected to the Cortes. Baldwin's correspondence to Darlington in 1815 says that Philadelphia was much pleased with the lectures of Chev. Correa da Serra.

[7] The records of this society were found by Mr. James Anglin, the predecessor of the present book firm of W. H. Lowdermilk & Co., among some secondhand books and presented to Prof. Lester F. Ward about 1881 or 1882. On the death of Professor Ward in 1913 his library was given to Brown University. The Trustees of that Institution granted a formal request for these records from the present Botanical Society of Washington. After a careful study of the records the writer was authorized by the Society to deposit them for safe keeping in the Manuscript Division of the Library of Congress.

for a time every two weeks. The dues were five dollars a year, and to enforce attendance a fine of one dollar for regular meetings and fifty cents for special meetings was levied against members who did not attend and could not give a satisfactory excuse. The aims were, quoting from the constitution, "to collect, arrange, preserve and describe all the vegetable productions within the limits of the District . . . . to publish quarterly, if deemed necessary, whenever the Society shall have obtained a full knowledge of all the vegetable productions of the said District a Flora with colored plates. . . . . ." At one time every member attending was required to bring a plant. The thirteen charter members consisted of John Boyle, W. A. Bradley, Dr. John A. Brereton, Samuel Elliot, Jr., William Elliot, J. W. Hand, Dr. Henry Huntt, Major James Kearney, Rev. Dr. James Laurie, Dr. Alexander McWilliams, J. M. Moore, John Underwood, and George Watterson. During the, life of the Society six other members were elected and a seventh name is given on a committee, but there is no record of this person's election. These were, however, mostly expelled for non-attendance, and on May 6, 1822, Boyle, Brereton, Wm. Elliot, Kearney, McWilliams, and Underwood were the only remaining members. Jacob Bigelow of Boston, William Darlington of New Jersey, and William P. C. Barton of Philadelphia, prominent botanists of that time, were elected honorary members. After 1822 only one meeting a year was held until March 27, 1826, when the books belonging to the Society were ordered deposited in the Washington Library and Dr. McWilliams was authorized to take charge of the herbarium, after which the Society adjourned *sine die*. There is apparently no record of the ultimate disposition of the library and herbarium. The library contained at least 24 volumes listed in the Proceedings of the Society. We are informed by both the District Public Library and the Library of Congress that the copies of these works in their libraries bear no indication of ever having belonged to the Botanical Society of Washington. The plan of publication by the Society never materialized, but the Society did publish in 1819 a Florula Columbiensis of 14 pages, and listing 293 species. What was practically a second edition of this list was published

by William Elliot in 1822 in his Washington Guide. The list was furnished by Dr. Brereton and comprised 458 species, and the same list was repeated in editions appearing in 1826 and 1830; the 1837 edition had a few additions by William Rich.

One of the members of the Society, Dr. John A. Brereton, together with William Rich, also published between 1825 and 1830 three parts of the American Botanical Register with 24 colored plates, but these contain no reference to the District. William Rich was a brother of Obadiah Rich[8] of Georgetown, who published in 1814 a synopsis of the genus of American plants which at that time Muhlenberg considered to be an American edition of Persoon's "Genera." It is uncertain whether this referred to Persoon's Synopsis, 1805–1807, or his edition of Linnaeusa Systema Vegetabilium, 1797. Neither of these men belonged to the Botanical Society of Washington, but both were members of the Columbian Institute[9] of Georgetown, organized in 1816, which was more directly interested in agriculture and horticulture. The Botanical Society of Washington was invited to join the Columbian Institute in November, 1817, and agreed, providing the Institute would so alter its constitution as to admit the Society to the Committee on Botany and Agriculture, but this request was apparently refused. Dr. Alexander McWilliams submitted a list of District plants to the Columbian Institute in 1826, but the list was not published.

Following the dissolution of the Botanical Society of Washington in March, 1826, another organization known as the Botanical Club, according to Dr. Brereton's preface, was formed,

[8] Obadiah Rich, born at Truro, Massachusetts, in 1783, was a member of the Massachusetts Horticultural Society at least from March 5, 1805, to January 30, 1810. Under date of April 16, 1812, William Bentley, of Salem, Massachusetts, wrote a letter introducing him to Thomas Jefferson. In 1815 he was appointed U. S. consul at Valencia, Spain. From this until 1827 most of his time was spent there and at Madrid, and in the latter year he tried to sell his valuable collection of books to the Library of Congress, but failing in this most of them went to the New York Public Library. He settled in London in 1828 and died there January 20, 1850. For this note I am indebted to Dr. J. H. Barnhart, of the New York Botanical Garden, and to Dr. R. H. True, of the Department of Agriculture.

[9] For a history of this Institute see RICHARD RATHBUN in U. S. National Museum Bulletin 101: 1–85. 1917.

consisting of Dr. John A. Brereton, Alexander McWilliams, William Mechlin, William Rich, and Dr. James W. Robbins, the latter removing from the District the next year. In 1830 Dr. Brereton published under the title *Florae Columbianae prodromus*, a contribution listing 860 species of plants with date of flowering and root habit indicated. Mr. George Watterson, who had served as Secretary of the first Botanical Society, evidently felt that its workers had not been given proper credit for their part of the work, as in his papers at the Library of Congress there is one which had evidently been prepared for publication in which he states that Dr. Brereton was lame and unable to do any of the collecting but took charge of the specimens as they were brought in and occasionally ascertained their names. He also states that Brereton's work contained few if any more plants than were recorded in the journal of the Botanical Society. According to Prof. L. F. Ward,[10] this journal contained the names of only 370 plants.

The first Botanical Society passed a resolution on September 12, 1817, petitioning Congress to pass a law authorizing a lottery for the purpose of establishing a Botanical Garden in Washington under the superintendence of the Society, but the petition was without results. According to Dr. Richard Rathbun,[11] the Columbian Institute had received permission from Congress on May 8, 1820, to use five acres of land to establish a Botanical Garden. This was finally located between First and Third streets and Pennsylvania and Maryland avenues. Mr. W. B. Bryan states[12] that as the waters of the Tiber probably came nearly up to that level the ground was somewhat swampy and first had to be drained. On May 26, 1824, the grounds were extended and in 1825 they were inclosed. There seems to be no record of what improvements or plantings were made by the Columbian Institute, which went out of existence about 1836,

[10] See COVILLE, FREDERICK V. *Early botanical activity in the District of Columbia.* Rec. Columb. Hist. Soc. **5**: 193. 1901.

[11] Bull. U. S. Nat. Mus. **101**: 12. 1917.

[12] BRYAN, WILHELMUS B. A history of the National Capital **1**: 314. 1914; **2**: 29, 326. 1916.

the Garden then being taken under government care as a part of the Capitol grounds. The Institute had expended $1500 on the grounds for walks and plantings and asked Congress to be reimbursed, but this request was not granted.

The National Institute was formed in the spring of 1841 with rooms in the Patent Office. The plants of the Wilkes Expedition of 1838 were at once placed in their care, as were all other Government scientific collections. Two small frame hot houses on the northern part of the Patent Office square were used to store part of the botanical collection. This Institute at one time had 1600 members, but went out of existence about 1860 or 1861[13] due to the taking over of the Government collections by the Smithsonian Institution, the National Institute having failed to obtain control of the Smithson fund on account of it being a purely private institute. The Smithsonian Institution was incorporated August 10, 1846. The building was not started until May, 1847, and was completed in 1855. The Government collections, presumably including plants which had previously been at the Patent Office under care of the National Institute, were turned over to the Smithsonian Institution in 1858 and the collections of the National Institute in 1861.[14] The collection of plants was transferred from the Smithsonian Institution to the U. S. Department of Agriculture in 1868 and was returned to the National Museum July 1, 1896. In 1851 the frame buildings above referred to were moved to the present site of the Botanical Garden. This site, which soon came to be recognized officially as the Botanical Garden, was placed in charge of W. D. Breckenridge, botanist of the Wilkes Expedition. William R. Smith, the late Superintendent, came to the Garden from the Kew Gardens in England in 1853 and remained until the date of his death.

[13] Encyclopedia Britannica ed. II. **25**: 274. 1911. Bryan (loc. cit.) states that it went out of existence in 1846 when the Smithsonian Institution was organized and that its collections were then turned over to the new institution. The Proceedings of the National Institute were, however, published as late as January, 1857, a set of which is in the library of the U. S. Department of Agriculture.

[14] Encyclopedia Britannica (loc. cit.). The National Museum was not officially mentioned by Congress until 1875, in connection with caring for the collections from the Philadelphia Centennial. It was erected in 1881.

The second nurseryman in the District, John Adlum,[15] for whom the genus Adlumia was named, like the first, devoted his attention from 1816 to 1836 mostly to grape culture. He owned about 140 acres of land, and his house, which was recently torn down, was located at the southeast corner of the Bureau of Standards, the old well being the only thing left to mark the site. Part of the northern slope of the valley directly south of the Bureau of Standards is still covered with a great tangle of grape vines, some of them being of considerable size. It is also possible to make out fairly well definite rows in which these vines were planted.

Joshua Pierce, from 1823 to 1869, was the first to conduct a general nursery in the District, consisting of about 82 acres located in Rock Creek Park, where the old stone house still stands.

The nursery of John Saul, consisting of about 120 acres, was located on Seventh Street Road from 1854 to 1897. The catalogues of this nursery indicate that the variety of stock was probably far ahead of that of any other nursery in this country at the time. Saul was a member of the District Parking Commission from the time of its origin until his death. On arriving in Washington in 1851 he, under the supervision of Andrew J. Downing, took charge of the improvements of Public Grounds, including the Mall, Smithsonian Grounds, Lafayette Square, and, in conjunction with W. D. Brackenridge, the Smithsonian Grounds. On the death of Downing in 1852 the appropriation by Congress was not renewed and Saul at once went into business for himself at Seventh and N Streets, N. W., where he conducted a seed business for many years.

From 1831 to 1874 the works by Dr. Leonard Gale and by W. D. Haley[16] were the only publications relating to the District flora and apparently very little botanical collecting was done. A small collection made here about 1860 or earlier by Dr. Arthur Schott,[17] an army surgeon, is now at the Field Museum of Natural History in Chicago.

[15] For further details of this and other nurseries see SAUL, JOHN A. Records of the Columbian Historical Society, 10: 38–62, pls. 2–7. 1907.

[16] See Bibliography. He was chief examiner of patents from 1846–1857. For biography see the Gale Genealogy.

[17] See MILLSPAUGH, C. F. Field Columb. Mus. Pub. Bot. 1: 281, 345. 1896.

The next renewal of Botanical activity began with the organization of the Potomac Side Naturalists Club[18] on January 29, 1858, which originally consisted of T. R. Peale, Dr. E. Foreman, Dr. G. C. Schaefer, Dr. C. Girard, Dr. F. V. Hayden, Dr. J. G. Cooper, Robert Kennicott, Prof. W. W. Turner, Dr. Wm. Stimpson, and W. R. Smith. Major W. Rich and W. Mechlin were included as the only members of the former Botanical Society and the following were among those later elected: J. S. Newberry, B. G. Wilder, T. H. Rothrock, Elliot Coues, Dr. Arthur Schott, H. Engelmann, M. S. Bebb, E. Bebb, and Thos. Eggleston, Dr. G. Suckley, F. B. Meek, and R. Ostensacken were elected as temporary residents. This society adjourned *sine die* on March 26, 1856, but was resurrected on May 1, 1873, at a meeting of the house of Prof. W. H. Seaman, and included Dr. Arthur Schott, H. Engelmann, M. S. Bebb, E. Bebb, Prof. S. F. Baird, Dr. Theodore Gill, and W. R. Smith, and reached a membership of 58. A committee consisting of Dr. George Vasey, Prof. J. W. Chickering, Dr. E. Foreman, Prof. Wm. H. Seaman, and Mr. Lester F. Ward was appointed to prepare a new District Flora with the result that a catalogue of 1083 species was published in 1876 and 117 additions were made during 1877.[19] The last meeting was held February 11, 1878, and in 1880 the Biological Society of Washington was organized with most of the old members of the Potomac Side Naturalists Club as members. Numerous papers on botany have been since published in their Proceedings.

Previously to 1869 there had been no official government botanist in Washington, although several botanists had been connected officially with various government exploring expeditions, but Charles C. Parry was now appointed botanist of the Department of Agriculture and served until 1871. He was followed on April 1, 1872, by George Vasey, who retained this position until his death March 4, 1893, and was succeeded by the present incumbent, Frederick V. Coville, on March 8, 1893.

[18] See CHICKERING, J. W., in Science, n. ser. **23**: 264–265, 1906, for detailed history.

[19] See bibliography under Flora Columbiana.

Prof. Lester F. Ward began collecting plants in the District of Columbia in the spring of 1872. It was September, 1880, when he first decided to prepare a catalogue of District plants, and on January 22, 1881, he presented to the Philosophical Society of Washington a paper entitled Field and Closet Notes on the Flora of Washington and Vicinity, in which he outlined his plan for a new catalogue of District plants, the character of his work on the subject for the preceding four years, and presented the manuscript of his catalogue with its introduction for inspection. On May 6, 1881, the same data but in more detail were presented before the Biological Society of Washington. After going over the subject with Prof. S. F. Baird the manuscript was accepted for publication as a bulletin of the U. S. National Museum and went to the printer on June 22, 1881. The check list was added in 1882. Some copies of the completed Flora were issued without the map on March 14, 1882, and not accepted, but it was completed April 12, 1882.[20]

Six supplements to Ward's Flora were published from 1884 to 1901 by Ward, Knowlton, Holm, and Steele and this period marks the beginning of a very large increase in the number of botanists, using the term in a broad sense, in the District of Columbia. This was due to the increase of the staff of the Department of Agriculture. The larger proportion were pathologists engaged primarily in economic work and there did not result any greatly increased activity in making known the District flora.

Dr. Ferdinand Blanchard, a well known botanist of Peacham, Vermont, was employed at the Census Office from 1890 until his death in 1892 and did considerable local collecting. Many of his specimens are in the National herbarium.

At the beginning of this period or about November, 1890, there was organized the Botanical Club of Washington, but for unknown reasons it was short lived, the last meeting being held April 7, 1892. No complete list of members exists, but the records of the bi-monthly meetings[21] refer to at least 39 members, in-

[20] WARD, L. F. Glimpses of the Cosmos, 2: 448–462. 1913.

[21] The record book is now in the possession of Mr. L. H. Dewey, the last secretary of the Club.

cluding 9 ladies, among whom were Vernon Bailey, J. W. Chickering, F. V. Coville, L. H. Dewey, D. G. Fairchild, B. T. Galloway, J. M. Holzinger, L. O. Howard, F. H. Knowlton, C. L. Marlatt, J. N. Rose, W. H. Seaman, E. F. Smith, Theobald Smith, Effie A. Southworth, C. W. Stiles, W. F. Swingle, W. A. Taylor, George Vasey, wife and daughter, M. B. Waite, L. F. Ward, and T. A. Williams.

The Botanical Seminar, an informal society without regular officers, was organized early in 1893 by Messrs. Waite and Fairchild, including as charters members Frederick V. Coville, D. G. Fairchild, B. T. Galloway, Theodore Holm, E. F. Smith, and M. B. Waite. This society grew rapidly, meeting at the homes of the members, until a limit of 25 was reached. Then, as the members were mostly interested in plant pathology and physiology, those interested in systematic botany met at the home of C. L. Pollard on November 11, 1898, and formed the Washington Botanical Club, with Dr. E. L. Greene as President and Mr. Pollard as Secretary. These meetings also were held at the members' homes, and the rapid growth in the next three years again brought the society to the point of necessity of restricting its membership, if the meetings were to be continued at private residences. As a result a committee consisting of O. F. Cook, M. B. Waite, and H. J. Webber for the Botanical Seminar and W. R. Maxon, C. L. Pollard, and David White for the Botanical Club were appointed to consider a combination of the two organizations and the securing of adequate quarters for caring for the constantly increasing number of botanists in Washington, with the result that the present Botanical Society of Washington was formed in November, 1901, with A. F. Woods, President; Frederick V. Coville, Vice-president; C. L. Pollard, Recording Secretary; H. J. Webber, Corresponding Secretary; and W. H. Evans, Treasurer. At the end of six months the membership was 57, and has constantly increased since, until at the present time it has reached 175. The society is probably the largest local organization composed entirely of professional botanists.

But little known and yet unique was the National Science Club for Women, although national in character, yet most of

its activities local. It was incorporated April 8, 1893, and issued from Washington Annual Proceedings and a Monthly Journal, but the club apparently went out of existence the latter part of 1899. Numerous botanical papers were published but none relating specifically to local botany.

Feeling the need of a flora of the District with notes and keys that could be used by local amateurs and by the school teachers and children, Mr. C. L. Pollard issued a prospectus with sample pages of such a flora about 1896, and while many of the families were subsequently written up the project was never completed. In continuation of this idea a number of the systematists in the Botanical Society of Washington formed a Seminar for discussing local flora work early in 1906, and as a basis for such work the writer prepared and issued (letterpress copy) in June of that year a compilation of all reported occurrences of plants in the District together with such additions as members of the Seminar could supply. The cards upon which the list was based were distributed by families to various local botanists who were to prepare these families. The work for the next few years was of a desultory character until 1912 when bi-monthly Seminar meetings for work on the local flora were begun at the instigation of Prof. A. S. Hitchcock, and have been held continuously up to the present time. Assignments of families were made to about thirty botanists, but pressure of official duties has resulted in the withdrawal of a few before the completion of the work.

RADIOTELEGRAPHY.—*Resonance measurements in radiotelegraphy with the oscillating audion.* L. W. AUSTIN, U. S. Naval Radiotelegraphic Laboratory.

For purposes of rough tuning, many workers have doubtless made use of the click heard in the telephones of an oscillating audion circuit when it is brought into resonance with another circuit at proper coupling. As the resonance click has apparently not been mentioned in any of the publications on radiofrequency measurements, it seems probable that it is not generally known that this click offers by far the quickest and simplest

means of making nearly all measurements depending on the determination of resonance. The accuracy is quite equal to that obtainable with sensitive thermoelements, and greatly superior to the accuracy of the detector and telephone method.[1]

Since the audion circuit itself is not suited to exact calibration, the substitution method is generally used. The following examples illustrate the procedure:

Capacity of an antenna by substitution. The antenna is loaded with inductance so as to give a wave length of five to ten times the fundamental, then the oscillating audion circuit is coupled to the antenna inductance and the audion tuning condenser varied until a click is heard in the telephones. In general, if the coupling is close, the click will be heard at different points with increasing and decreasing condenser capacity. The coupling should then be loosened until both clicks appear at the same condenser setting, or, if this is impossible, the mean setting is taken provided the points are less than a degree apart. Next, leaving the audion condenser on the resonance point, the ground and antenna are disconnected from the antenna inductance and replaced by the calibrated variable substitution condenser. This last is adjusted to resonance with the audion circuit exactly as described above, and the capacity of the condenser is then equal to that of the antenna, subject to a small correction for the natural antenna inductance.

Wave length of a distant station. The receiving antenna and secondary oscillating circuit are first tuned exactly to the distant station, preferably at loose coupling, the audion tuning condenser being adjusted to give the dead point of the beats in the case of continuous wave reception. Next, without changing anything in the antenna or secondary a wave meter is coupled to the secondary and adjusted to resonance by the click method. The reading of the wave meter gives at once the wave length of the sending station.

In a similar way, wave meters can be compared and condensers and inductances calibrated, either by substitution or by making

[1] Care must be taken regarding harmonics, in all measurements in which bulbs are used for excitation.

use of the well-known relation existing between the product of inductance and capacity and the wave length.

Besides the simplicity and quickness of this method, it has the advantage that it does away with the necessity for all auxiliary apparatus in the wave meter, and enables measurements of the highest accuracy to be taken on shipboard and in other places where the use of sensitive galvanometers is impossible.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. The abstracts should conform in length and general style to those appearing in this issue.

GEOLOGY.—*Oil shale of the Uinta Basin, northeastern Utah, and results of dry distillation of miscellaneous shale samples.* DEAN E. WINCHESTER. U. S. Geol. Survey Bull. 691–B. Pp. 27–55, with maps, sections, and illustrations. 1918.

The geography and geology of the oil shale are described, and the results of many distillations tests are given, which show yields of oil up to 90 gallons per ton of shale. A great many of the samples tested carried from 20 to 30 gallons of oil per ton of shale. There seems to be ample proof that the oil distilled from the oil shale of the Green River formation is largely obtained as a result of the destruction of the partly bituminized vegetable matter contained in the shale. Invariably the shale showing the larger percentage of vegetable débris will yield the most oil and vice versa, but shale beds occurring between beds of rich oil shale may be fully as compact and fine grained and yet yield no oil on distillation. There appears to be no reason why oil migrating into the shales should not penetrate all alike, and the oil might be expected to follow the beds of least resistance—that is the coarser beds of sandstone which are interbedded with the shales. It seems certain that if the oil had migrated into the shale such porous sands would contain at least small quantities of oil that might be obtained by distillation.

It is probable that the oil shales of the Green River formation may have been the source of all the vein hydrocarbons of the Uinta Basin as well as of the asphaltic material that saturates certain sandstones of the region.

R. W. STONE.

GEOLOGY.—*The Cosna-Nowitna region, Alaska.* HENRY M. EAKIN. U. S. Geol. Survey Bull. 667. Pp. 54, with maps and illustrations. 1918.

The Cosna-Nowitna region, which lies between Mt. McKinley and Yukon River on the north, is stratigraphically and structurally very complex. The geology presents much variety and many of the rock terranes recognized in this field can not yet be definitely correlated with the formations in other parts of the Yukon basin. Yet the age of at least two formations—the Ordovician and Devonian limestones—has been pretty definitely established, and these determinations will help to solve some of the stratigraphic problems of central Alaska. The correlation of the pre-Ordovician metamorphic sediments of the Cosna-Nowitna region with the Birch Creek schists of the Yukon-Tanana region also seems justified. There are some large areas of volcanic rocks and smaller ones of intrusive granite. The dominant trend of the structural features is northeasterly. The general events of the tectonic history of the region appear to include extensive crustal deformation in pre-Ordovician, post-Ordovician, post-Devonian, and probably late Mesozoic or early Tertiary time. The development of the present topography of the region is discussed.

R. W. STONE.

GEOLOGY.—*The coal fields of the United States. General introduction.* MARIUS R. CAMPBELL. U. S. Geol. Survey Prof. Paper 100–A. Pp. 1–33. 1917.

A general introduction to a series of papers describing the coalfields of the United States. This paper defines the various kinds of coal, classifies and defines the coal areas, gives the production and estimates the tonnage of coal in the United States, and gives analyses of representative coals from many States.

R. W. STONE.

GEOLOGY.—*Cannel coal in the United States.* GEORGE H. ASHLEY. U. S. Geol. Survey Bull. 659. Pp. 126, with maps, sections, and illustrations. 1918.

This report defines, describes, and classifies cannel coal, and discusses its mode of occurrence, uses, production, value, and distribution. Cannel coal is one of the richest substances in hydrocarbons known, and it was because of the demand for the lighter hydrocarbons for use in chemical industry that this report was prepared.

R. W. STONE.

GEOLOGY—*The structure of parts of the central Great Plains.* N. H. DARTON. U. S. Geol. Survey Bull. 691–A. Pp. 26, with maps, sections, and illustrations. 1918.

This report shows the structural features, such as domes and anticlines, that occur at many places in Kansas, Nebraska, South Dakota, Colorado, and Wyoming. While there is no evidence that the strata contain oil or gas in commercial pools these folds are more favorable for the location of tests than the basins or the monoclines. Only the drill can determine whether or not oil is present. It is believed that a presentation of all available facts as to structural conditions in this region is warranted by the prevailing great interest in the possibility of the occurrence of petroleum and gas.

R. W. STONE.

ZOOLOGY.—*The unstalked crinoids of the Siboga expedition.* (Monograph XLII*b* of: Uitkomsten op zoologisch, botanisch, oceanographisch en geologisch gebied verzameld in Nederlandsch Oost-Indie 1899–1900 aan boord H. M. Siboga onder commando van Luitenant ter zee I^{e} kl. G. F. Tydeman.) AUSTIN H. CLARK, U. S. National Museum. Leiden, March, 1918. Pages i–ix, 1–300. 17 text figures; plates I–XXVIII (except IV and X, the originals of which were lost on the "Laconia"), of which plates I–X are in colors.

This memoir, which is an extension of and a supplement to the *Crinoids of the Indian Ocean* published by the same author (Calcutta, 1912), gives a monographic account of the comatulid fauna of the East Indies. Keys to all the species, genera, and families are included.

The identity of the urinoid fauna of the Arc Islands with that of Australia is mentioned, and the close similarity between the Sumbawa-Moluccas fauna and that of southern Japan is emphasized.

There are known at present 576 species of recent crinoids, distributed in 142 genera; in the course of her explorations the "Siboga" collected 163 species, representing 71 genera; of these 73 species and 3 genera were new to science.

A. H. C.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

WASHINGTON ACADEMY OF SCIENCES

A special meeting of the Board of Managers was held on July 15, 1918. Resolutions were passed urging the War Industries Board and all other authorities concerned to grant unrestricted supplies of materials and labor to the publishers of scientific periodicals, in order that this country shall not fall behind its Allies or the enemy contries in this phase of the encouragement of scientific research.

The following persons have become members of the ACADEMY since June:

Mr. JAMES MADISON HILL, 2ND, U. S. Geological Survey, Washington, D. C.

Dr. ROBERT TRACY JACKSON, Peterboro, New Hampshire.

Mr. FRANK J. KATZ, U. S. Geological Survey, Washington, D. C.

Captain ALBERT PRESCOTT MATTHEWS, University of Chicago, Chicago, Ill.; and Quartermaster's Office, Headquarters of Central Departpartment, Chicago, Ill.

Mr. H. D. MISER, U. S. Geological Survey, Washington, D. C.

Mr. RALPH WALTER STONE, U. S. Geological Survey, Washington, D. C.

Lieut. DAVID L. WESTER, National Research Council, 1023 Sixteenth Street, Washington, D. C.

ROBERT B. SOSMAN, *Corresponding Secretary.*

PHILOSOPHICAL SOCIETY OF WASHINGTON

The 806th meeting of the Society was held at the Cosmos Club, April 27, 1918. Vice-President SOSMAN in the chair; 49 persons present. The minutes of the 805th meeting were read in abstract and approved.

The first paper on *Fog and cloud* was presented by W. J. HUMPHREYS. This paper was illustrated by lantern slides.

The deposition of dew and the sweating of ice pitchers are familiar examples of the condensation of atmospheric moisture on relatively cold objects. In exactly the same way condensation takes place on the innumerable dust motes and other nuclei in the atmosphere whenever by expansion or otherwise it is cooled to a temperature below the dewpoint.

Condensation on the nuclei of the atmosphere is divided primarily into fog and cloud, but a sharp distinction between them that would enable one always to say which is which is not possible. In general, however, a fog differs from a cloud only in its location. Both are owing, as explained, to a cooling of the atmosphere to a temperature below its dew point, but in the case of the cloud this cooling usually results from vertical convection, and hence the cloud is nearly always separated from the earth, except on mountain tops. Fog, on the other hand, is induced by relatively low temperatures at and near the surface, and commonly itself extends quite to the surface, at least during the stage of its development. In short, fog consists of water droplets or ice spicules condensed from and floating in the air near the surface; cloud, of water droplets or ice spicules condensed from and floating in the air well above the surface. Fog is a cloud on the earth, cloud a fog in the sky.

Fog may be divided into two types according to the process by which the necessary cooling of the air is produced. These are *radiation fog* and *advection fog*. The first, or radiation fog, occurs during still clear nights when the atmosphere is rather humid. On such occasions the surface of the earth and the lower atmosphere are cooled by radiation to a temperature sufficiently low to induce both surface and volume condensation. Hence the name "radiation fog." The other type, to which the name "advection fog" is given, is the result of the horizontal flow of warm humid air to a colder region or of cold air to a relatively warm humid region.

Clouds cannot be so simply and logically classified as fogs. Their exact mode of production, whether by convection, mixing, or radiation, is not always obvious. Hence they generally are classified according to appearance and position. The fundamental types are: *cirrus*, *stratus*, *cumulus*, and *nimbus*. To these are added several alto, fracto, and combination types, such as "alto-stratus," "fracto-stratus," and "cirro-stratus." In addition to all these various special and more or less unusual forms are recognised, such as "billow cloud," "lenticular cloud," "banner cloud," "scarf cloud," "mammato-cumulus," et cetera.

Not all altitudes are equally frequented by clouds. There are five elevations of maximum and five of minimum cloudiness, each of which may be simply explained.

Discussion: Messrs. BAUER and FORD discussed this paper.

The second paper on *Notes on dip-of-horizon measurements made on the "Galilee" and "Carnegie"* was presented by Mr. W. J. PETERS, and was illustrated by lantern slides.

This paper states that while reliable observations have shown the sea-horizon to have been elevated occasionally 10′ to 15′ above its normal position by refraction, such large values are probably confined to the borders of equatorial and polar currents and to small areas of water swept by breezes blowing directly off heated lands or office fields.

In over 3000 observations taken during ten years work at sea by the Department of Terrestrial Magnetism, the refraction at the horizon

has never been found to exceed 2.4′ for a height of eye of 18 to 24 feet.

A short description of the Pulfrich dip-measurer was given with an account of the difficulties of observing at sea both with this instrument and all instruments in general.

The paper concluded with an exhibition of the results of an adjustment of all the observations made on the *Galilee* and those made on the recent cruise of the *Carnegie*.

Comparisons with the results of other observers were shown as well as comparisons with the standard tables.

The latter comparisons showed that the standard tables of dip-of-horizon are sufficiently accurate for the navigator and cannot be improved by the introduction of a temperature or a temperature-difference argument when the result is required for the oceans.

The 807th meeting was held at the Cosmos Club, May 11, 1918. President BURGESS in the chair; 42 persons present. The minutes of the 806th meeting were read in abstract and approved.

The first paper on *The constitution of the gas ion* was presented by A. Q. TOOL. This paper was illustrated by lantern slides.

The mobility of the negative ions was determined by three closely related methods. The first was the usual alternating potential method, which is a modification of Rutherford's original method. This gave values which were larger than that for the so-called normal ions, where the normal ion is defined as the ion whose mobility obeys the law $u = kP$. These large values were shown to be due to numerous fast ions still growing as well as a large number of electrons.

The second method may be considered as the reverse of the one above, the potential in the positive or accelerating half period being maintained constant while that in the negative half period was varied in determining the current curve. A "critical potential" was then found from the break in this curve which gave mobility values as low or lower than that usually obtained for the normal ion. This indicated the presence of ions larger than the normal ion. Their mobility obeyed the law cited above.

The third method made use of the relation existing between the usual saturation current curve and the current curve obtained in Rutherford's method when the alternating potential is produced by a rotary commutator. By this third method it was possible to show something of the mobility distribution of the ions in a gas. Large numbers of normal ions were found to exist at all pressures in air even when carefully dried.

Through the use of these three methods it was possible to detect ion growth, also ion disintegration. This latter was especially marked in air nearly saturated with water vapor. The results strongly supported the complex ion theory.

The second paper, on *Corresponding changes in the earth's magnetic state and in solar activity, 1888–1916*, was presented by Mr. L. A. BAUER and was illustrated by lantern slides.

The prime object of the present investigation is to ascertain to what extent the earth's magnetic state at any time may be dependent upon solar conditions, i.e., upon causes exterior to the earth. The purpose is not to determine anew the relation between fluctuations in the earth's magnetism about some base line or normal value and fluctuations in the sun's activity, but rather to find out whether the base line or normal value itself varies with solar activity, and, if so, how. Thus during periods of intense sun-spot activity, violent fluctuations in the earth's magnetism are known to occur. These fluctuations may continue for a few hours or for a few days and then subside. There is often found to be an after effect, of a quiescent, persistent character, as the result of which the earth's magnetization remains below par for several months, or more, after the apparent cessation of the magnetic storm.

It is a matter of no little interest to know whether the earth's magnetic state ever completely returns to a former state after having experienced such magnetic-storm effects as described. Some previous investigations bearing on this question had been made and reported upon by the author on the basis of data extending over a few years at the most. Now, however, the investigation applies to data extending over a period of about 2½ sun-spot cycles.

It is shown that the absolute values of the magnetic elements that define the earth's magnetic state at any time vary in a definite and in an appreciable manner with change in the sun's activity, as revealed to us by sun-spottedness and by values of the solar constant of radiation. The two sets of measures of solar activity serve to supplement each other in determining the causes for the anomalous changes in the earth's magnetic state from year to year.

The conclusions indicate that in the selection of a common epoch to which the magnetic elements resulting from a magnetic survey shall be reduced, consideration may have to be paid to the position of the epoch with reference to the years of maximum and minimum solar activity.

The conclusions also confirm those reached by the author in a paper presented before the Society in October, 1904, viz, that the secular variation of the earth's magnetism, besides being caused by a system of forces below the earth's surface, is also appreciably caused by a system above the earth's surface, and that the secular variation results not only from changes in the direction of magnetization, but likewise from changes in the intensity of magnetization of the earth.

H. L. Curtis, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

A Washington Section of the American Institute of Mining Engineers was organized on June 20, 1918. The officers elected were: Mr. HERBERT HOOVER, of the Food Administration, chairman; Dr. H. FOSTER BAIN, of the Bureau of Mines, and Dr. DAVID WHITE, of the U. S. Geological Survey, vice-chairman; Mr. HARVEY MUDD, secretary.

The National Research Council, at the request of the Secretary of War and the Secretary of the Navy, has organized a committee on explosives investigations. The membership of the committee is as follows: Dr. CHARLES E. MUNROE, of George Washington University, chairman; Mr. L. L. SUMMERS, of the War Industries Board; Lieut.-Col. W. C. SPRUANCE, JR., of the Ordnance Department of the Army; and Lieut.-Commander T. S. WILKINSON, of the Ordnance Department of the Navy.

The experimental ammonia plant and laboratory of the Bureau of Soils at Arlington, Virginia, has been transferred to the Nitrate Division of the Ordnance Department of the Army. The work is in charge of Dr. R. O. E. DAVIS and Mr. L. H. GREATHOUSE.

All of the "gas warfare" work of the Army has been consolidated under a new division of the War Department, the "Chemical Warfare Service," under Major General WILLIAM L. SIBERT. The experimental work heretofore carried on by the Surgeon General's Office and the Ordnance Department are included, as well as the American University Experiment Station of the Bureau of Mines, which, with its entire personnel, civilian and military, is transferred to the control of the War Department for operation under the director of gas service, by executive order of the President dated June 25, 1918. The Chemical Warfare Service also has the responsibility of providing chemists for all branches of the government and of assisting in the procurement of chemists for essential industries. General PERSHING has been directed to conform his organization in France to that adopted here.

The former "chemicals and explosives section" of the War Industries Board has been reorganized into two divisions: a "chemicals division" in charge of Mr. CHARLES N. MACDOWELL, and an "explosives division," in charge of Mr. M. F. CHASE. The chemicals division is subdivided into the following sections: acids and heavy chemicals, artificial and vegetable dyes, alkali and chlorine, chemical glass and stoneware, coal gas products (benzol, toluol, etc.), rare gases, creosote, electrodes and abrasives, ethyl alcohol, ferroalloys (chromium, manganese, tungsten), fine chemicals, nitrates, paints and pigments, plati-

num, refractories, sulfur and pyrites, tanning materials, wood chemicals. The consulting staff, mentioned in this column of June 19, 1918 (p. 416), consists at present of Dr. E. R. WEIDLEIN, chief, Prof. N. R. MOODY, and Dr. THOMES P. MCCUTCHEON, of the University of Pennsylvania.

The Committee on Mineral Imports and Exports has finished its work of formulating programs for the minimum importation of ores and minerals, and the members of the committee have taken up other work. Prof. C. K. LEITH has been appointed mineral adviser to the War Industries Board from the standpoint of the conservation of shipping, Mr. J. E. SPURR is in charge of the war minerals investigation work of the Bureau of Mines, and Mr. POPE YEATMAN continues in charge of the Non-Ferrous Metals Divisions of the War Industries Board.

The New National Museum has been closed to the public by the board of regents, as all available space in the building has been occupied by the Bureau of War Risk Insurance. It is expected that the Museum will be again opened when the new office building of the Bureau, at Vermont Avenue and H street, is completed.

Dr. CLEVELAND ABBE, meteorologist of the Weather Bureau and editor of the *Monthly Weather Review*, was removed from office by the Secretary of the Interior on July 3, 1918. The chief of the Bureau, Prof. C. F. MARVIN, in transmitting the order, stated that the dismissal resulted from Dr. Abbe's "long-standing and generally well-known friendly sympathies for the imperial German government," and that investigations leading to dismissal were initiated by sources outside of the Bureau and carried forward by the Department of Justice. Dr. Abbe has denied that he is disloyal and has requested an opportunity to reply to any charges presented.

Dr. OLAF ANDERSEN, petrologist at the Geophysical Laboratory, has resigned in order to accept the position of government geologist and director of an experimental silicate laboratory for the Norwegian Government, in Kristiania. Dr. Andersen will leave in September or October.

Dr. S. J. BARNETT has resigned as professor of physics at the Ohio State University and has accepted the post of physicist in charge of experimental work in the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, beginning his work there on July 15.

Dr. F. E. BREITHUT, assistant professor of chemistry at the College of the City of New York, is on leave of absence and has been commissioned a major in the Chemical Warfare Section.

Dr. EDGAR BUCKINGHAM, of the Bureau of Standards, has been appointed physical associate to the scientific attaché to the American embassy at Rome.

Mr. GEORGE A. BURRELL, in charge of the American University Experiment Station of the Bureau of Mines, has been commissioned a colonel in the Chemical Warfare Service, National Army.

Major WILLIAM B. GREELEY, formerly of the Forest Service, has been commissioned a lieutenant colonel. He is at present with the American Expeditionary Forces in France.

The honorary degree of A.M. has been conferred by Harvard University on Mr. HENNEN JENNINGS, consulting mining engineer.

Prof. LAUDER W. JONES, formerly of the University of Cincinnati, and recently appointed head of the department of chemistry of the University of Minnesota, is on leave of absence and is engaged in research at the American University Experiment Station.

Dr. THOMAS J. KELLEY has been appointed professor of gynecology in the Medical School of Georgetown University, as the successor of Dr. ISAAC STONE, who resigned in June after twenty-six years of service with the Medical School. Dr. JAMES M. MOSER and Dr. JOHN A. FOOTE have been appointed associate professors of pediatrics.

Prof. A. E. KENNELLY, acting head of the department of electrical engineering of the Massachusetts Institute of Technology, is in Washington for the summer on special work for the Signal Corps.

Dr. JOHN HARPER LONG, Professor of Chemistry at the Northwestern University Medical School, Chicago, Illinois, and a member of the ACADEMY since 1899, died at his home in Evanston on June 14, 1918, in his sixty-first year. He had been with Northwestern University for the past thirty-seven years, and had been active in physiological chemical research as well as in the public service, having been a member of the referee board of the Department of Agriculture, a member of the revision committee of the Pharmacopoeia, and president of the American Chemical Society (in 1903). He was the author of several text-books of chemistry.

President R. C. MACLAUREN, of the Massachusetts Institute of Technology, came to Washington in July to act as educational head of a students' army training corps, organized to give military instruction to student volunteers who are not yet of draft age.

Mr. EDWIN H. PAGENHART, hydrographic and geodetic engineer of the U. S. Coast and Geodetic Survey, has been transferred to the Corps of Engineers (Reserve) of the army, with the rank of Captain.

Dr. RICHARD RATHBUN, a charter member of the ACADEMY, died at his home, 1622 Massachusetts Avenue, on July 16, 1918. Dr. Rathbun was born at Buffalo, New York, January 25, 1852. His earlier years were spent in scientific work for the Boston Society of Natural History, the Imperial Geological Commission of Brazil, the department of zoology of Yale University, and the United States Fish Commission. Since 1897 he had been Assistant Secretary of the Smithsonian Institution, and had been in charge of the National Museum since 1899. His scientific publications were concerned chiefly with Brazilian paleontology and the marine invertebrates and the fisheries of the United States. Dr. Rathbun was a member of the Biological Society of Washington, a past president of the Philosophical Society of Washington, and a past president of the Cosmos Club.

Dr. J. N. ROSE, associate curator of the Division of Plants, National Museum, left Washington on July 22 for an extended trip of botanical exploration through Ecuador, under the auspices of the U. S. National Herbarium, the U. S. Department of Agriculture, the New York Botanical Garden, and the Gray Herbarium. His headquarters during the summer will be at Huigra, and his address will be care of American consul at Guayaquil, Ecuador.

The Reverend GEORGE MARY SEARLE, C.S.P., superior general of the Paulist Fathers from 1904 to 1909, and formerly professor of mathematics and director of the astronomical observatory at the Catholic University, died on July 8, 1918, at the age of seventy-nine. He was born in London, England, June 27, 1839, graduated from Harvard University in 1857, and was connected at various times with the Dudley and the Harvard College Observatories, the U. S. Naval Academy, and the U. S. Coast and Geodetic Survey. He was a member of the Philosophical Society of Washington, and had been for many years a member of the ACADEMY, from which he had resigned but a few months ago.

Dr. W. F. G. SWANN left the Bureau of Standards on August 1, 1918, to take up his new work as professor of physics at the University of Minnesota.

Dr. WALTER T. TAGGART, professor of organic chemistry in the University of Pennsylvania, is engaged in war research for the Nitrate Division in Washington.

Prof. A. TANAKADATE, professor of physics in the University of Tokyo, and member of the Imperial Academy of Science, visited Washington in July on business connected with certain international scientific commissions whose activity has been interfered with by the war.

Dr. WILLIAM S. THAYER, of Baltimore, was elected a foreign member of the Académie de Médicine of Paris on July 2, 1918.

Prof. S. W. YOUNG, professor of physical chemistry at Leland Stanford Jr. University, is in Washington for the summer, engaged in war research at the Bureau of Standards.

N. H. DARTON, of the Geological Survey, will spend several months in New Mexico continuing his studies of the Redbeds, with special reference to the possibility of their containing potash deposits.

Withdrawn